Graphene systems with external perturbations

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Interactions between graphene systems and applied forces or inserted molecules often result in very interesting consequences that are sometimes useful as well. In this talk, I will present a couple of theoretical works exploring those aspects in various graphene systems. First, I will discuss an ideal strength of graphene as function of doping. There have been several works on variations of electronic structures in graphene systems with external forces. However, the effect of variation of electronic degree of freedom on their mechanical properties has not been explored well. It is shown that the ideal mechanical properties of graphene are strong functions of doping due to distinct electron-phonon interactions in graphene systems. Second, I will also discuss another aspect of realization of interesting electron-phonon interactions in bilayer graphene in spectroscopic measurements. When two layers in bilayer graphene slide each other, interlayer electronic interactions couple to intralayer phonon degrees of freedom that changes Raman and IR spectroscopic signals. Third, if time allowed, I will present a possible explanation on a recent astonishing experiment showing the unimpeded water permeation through graphene oxide membrane. It is shown that the interlayer distance and ice formation are important factors for perfect water penetrations and for complete blocking for other gases and liquids.